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Factors Influencing Adoption of Environmental Conservation Practices among Smallholder Farmers in Bahi District, Tanzania

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ABSTRACT

Background: Environmental conservation is vital for sustainable agriculture and natural resource management. In Bahi District, where smallholder farmers dominate crops and livestock production, serious environmental degradation including soil erosion, deforestation, and water pollution endangers sustainability and livelihoods. However, conservation methods are still not widely adopted.
Objective: This study aims to investigate the factors influencing the adoption of environmental conservation practices among smallholder farmers in Bahi District, Tanzania.
Method: The study employed a cross-sectional mixed methods research design. A total of 224 smallholder farmers residing in Bahi district were sampled using random sampling technique. Data were collected using structured questionnaire, and focus group discussions (FGDs). Structured questionnaire was tested using Cronbach alfa for internal consistency and found to be reliable ($\alpha = 0.87$). Data analysis was done using descriptive statistics (frequency and percent), and general linear model, specifically multivariate probit regression analysis which quantified the factors influencing adoption of different environmental conservation practices.
Results: The study showed that cover crops (63.4%), organic farming (44.6%), and agroforestry (41.1%) were the most adopted soil conservation methods, while reservoir building (25.4%) and water recycling (33.0%) were the primary water conservation techniques. Over 30% of farmers did not implement strategies for biodiversity conservation, flood control, or food/nutrient preservation. Statistical analysis indicated that environmental awareness strongly influenced biodiversity conservation ($\beta = 0.697$), while improved food security positively affected flood control ($\beta = 0.549$), pest management ($\beta = 0.840$), and food/nutrient conservation ($\beta = 0.870$). Economic incentives promoted soil conservation ($\beta = 0.804$), and peer influence enhanced flood control ($\beta = 0.509$) and water conservation ($\beta = 0.637$). Conversely, larger family sizes negatively impacted soil and biodiversity conservation. Education positively influenced soil conservation ($\beta = 0.707$) and water conservation ($\beta = 0.669$).

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Conclusion: The research concluded that interrelated social, economic, educational, and demographic elements continuously influence farmers'

Unique Contribution: This study adds unique insights on sustainable smallholder farming systems in the Bahi district by showing how interrelated demographic, educational, social, and economic variables influence farmers' adoption of environmental conservation measures.

Key Recommendation: Strengthening environmental conservation in Bahi District requires community-based education, economic support, and multi-stakeholder collaboration to sustain initiatives.

Keywords: Adoption, Environmental Conservation Practices, Smallholder Farmers, Bahi District

INTRODUCTION

Environmental degradation threatens both ecosystems and livelihoods worldwide, and Tanzania's Bahi district is a stark example. Between 2001 and 2023, the district lost approximately 600 hectares of tree cover to deforestation and fire (GFW, 2023). Over 60% of the area also suffers from medium to extreme levels of soil erosion and vegetation loss. These environmental stresses have a direct human cost. Households meet only half of their daily water needs during the rainy season and less than a quarter during the dry season (Zhan & Zhang, 2024).

In response, conservation practices such as agroforestry and reforestation are being promoted for their proven benefits. Yet, despite supports from the government, NGOs, and community initiatives, a persistent gap remains (Ardoin et al., 2020; UN, 2023). Smallholder farmers in Bahi have been inconsistent in adopting these methods, creating a disconnect between policy and practice.

Previous studies (Sarvade et al., 2019; Kumawat et al, 2020; Fatima et al., 2024) have explored the effects of a wide range of conservation practices, such as afforestation, agroforestry, drip irrigation, and water harvesting methods. These conservation practices have been shown to enhance sustainability, resilience, and reduce environmental deterioration. Despite the documented impact, limited information is available regarding the adoption and factors shaping the adoption of conservation practices, particularly in the Bahi district context. Kibassa (2013) and Myeya (2021) have documented that farmers in the Bahi district had started to use water harvesting strategies and intercropping methods. However, they overlooked the extent of adoption of these methods and failed to show the drivers for their adoption

This study aimed to examine the factors influencing the adoption of environmental conservation practices among smallholder farmers in the Bahi district. Specifically, the study assessed the level of adoption of environmental conservation practices and quantified the factors for farmers to adopt different environmental conservation practices.

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THEORETICAL FRAMEWORK

This study applies the Theory of Planned Behaviour (TPB) to examine factors influencing farmers' adoption of conservation practices. TPB suggests that behaviour is shaped by attitudes (perceived benefits and drawbacks), subjective norms (social influence and peer pressure), and perceived behavioural control (confidence in ability to act given resources and constraints) (Ajzen, 1991). Farmers' willingness to implement soil conservation, water management, and pest control depends on perceived advantages, community norms, and access to financial, technical, and infrastructural support. External factors such as policies, laws, extension services, and economic conditions also shape perceived control and adoption rates (Alverne, 2025). Using TPB, this study provides insights into social and psychological drivers of conservation adoption, guiding effective interventions (Asprooth et al., 2023)

1.1 CONCEPTUAL FRAMEWORK

The conceptual framework in Figure 1 reveals the relationships among several variables impacting farmers' adoption of conservation practices. Farmers' motivation and capacity to use sustainable conservation techniques are directly impacted by independent factors such as financial incentives, community influence, awareness-raising initiatives, training programs, and the perceived advantages of environmental conservation. Farmers' attitudes, perceptions, and understanding are shaped by these elements, which ultimately affect how they make conservation-related decisions. While community impact and awareness initiatives can strengthen favorable views toward conservation, financial incentives may act as a motivator (Wainaina et al., 2021). Farmers' technical proficiency is improved by training programs, and their dedication to sustainable methods is reinforced by the perceived benefits.

The adoption of conservation practices is influenced by multiple factors beyond behavioral intentions. Socioeconomic characteristics, environmental awareness, and government regulations significantly shape adoption outcomes (Xie & Huang, 2021). Supportive laws and policies create enabling environments, while awareness enhances farmers' understanding of long-term benefits. Socioeconomic factors such as family size, income, and education further determine the capacity to adopt these practices. Together, these elements interact with independent variables by either facilitating or constraining conservation adoption. This framework provides a structured lens for analyzing how social, economic, and regulatory factors collectively influence farmers' conservation behaviour.

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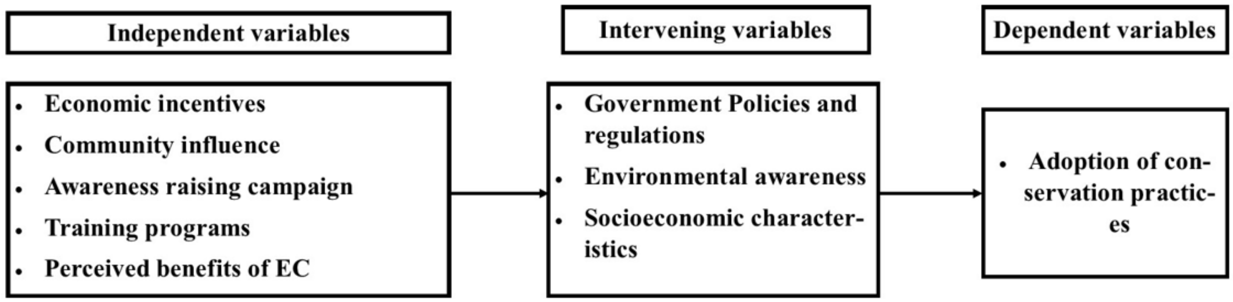

Figure 1: Conceptual framework; Source: Researcher, (2025)

2.0 MATERIALS AND METHODS

2.1 Description of the Study Area

Bahi District lies between latitude 6.1528° south of the equator and longitude 35.3027° east of the Greenwich meridian. The district is found in Dodoma region of Tanzania, and bordered on the east by the Chamwino District and Dodoma municipal, on the west by the Singida region, on the south by the Iringa region, and on the north by the Kondoa District.

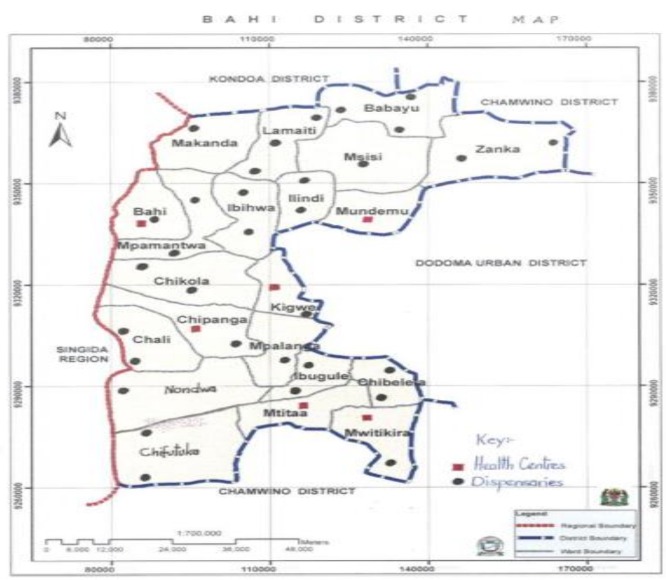

Figure 2: A map of Bahi District

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The district has a total area of 544,842 Square Kilometers, and about 70% of the area is suitable for agricultural activities (URT, 2017). Administratively, the District is divided into four divisions, 22 wards, and 59 villages. The temperature of the Bahi District varies from 18^{o}C to 31^{o}C, and the cool, dry season starts from June to September. Human activities such as agriculture, lumbering, fuel wood, grazing, charcoal extraction, and bushfires in the Bahi District contributed to vegetation loss and environmental degradation (URT, 2017). Figure 1 represents a map of the Bahi District.

2.2 Study Design

The study employed a cross-sectional research design. This design helps to measure the exposure and outcomes of a certain condition in the population at the same time and may establish their association (Setia, 2016). With this design, farmers' adoption of environmental conservation measures and the variables affecting these behaviours was effectively being recorded without the need for lengthy follow-up. This method allowed for a thorough evaluation of existing practices and determinants in a time- and resource-efficient manner.

2.3 Study Population and Sampling Techniques

Four wards were randomly selected from 22 in Bahi District to ensure fair representation of environmental and agricultural conditions. From each ward, three villages were randomly chosen, giving a total of 12 villages. Using village registers, households were selected through systematic random sampling, and from each, a household head or representative was interviewed. Depending on village population size, 14–18 respondents were randomly selected per village, yielding a total of 224 participants. This sample size was guided by similar rural agricultural studies (Kom et al., 2022) confirming its adequacy for representativeness, statistical reliability, and robust analysis in conservation practice research.

2.4 Data Collection

This study employed a structured questionnaire with closed- and open-ended questions. Cronbach alfa was used to examine the internal consistency of the structured questionnaire, and the results showed that it was reliable ($\alpha = 0.87$). To collect household-level data, focusing on conservation practices such as soil and water management, biodiversity preservation, nutrition, flood prevention, and pest control. Respondents, mainly household heads or representatives, also explained reasons for adopting these measures. To complement surveys, focus group discussions captured community attitudes, while key informant interviews with leaders and experts provided specialized insights. Questions assessed the extent of adoption full, partial, or none allowing analysis of patterns and factors influencing behaviour. Further, triangulation was done to cross-validate results and offering a more thorough comprehension of farmers' environmental conservation practices.

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2.5 Data analysis

Collected data were cleaned, coded in Excel, and analyzed in SPSS. Respondents' socioeconomic characteristics and adopted conservation practices were summarized using descriptive statistics. Multiple responses were coded as binary variables (Yes = 1, No = 0) and organized into multiple response sets for analysis. A multivariate probit model identified factors influencing participation in conservation activities. Qualitative data from open-ended questions, FGDs, and KIIs underwent thematic analysis, with responses categorized into themes of conservation practices and adoption reasons. Cross-analysis of quantitative and qualitative results provided a comprehensive understanding of farmers' conservation behaviors and the key factors motivating their adoption of environmental practice

3.0 RESULTS AND DISCUSSION

3.1 Socio-economic characteristics of the respondents

The socio-economic characteristics of respondents across the four wards (Bahi, Ibihwa, Mpamantwa, and Zanka) showed a higher representation of females (52.7%) with majority of the respondents aged between 20-40 years and, having an average age of 37.57±0.94 years. Youth are more active and energetic, and may play a significant role in environmental conservation. The study has shown that youth were found to be highly concerned with environmental issues and they actively participate in environmental conservation efforts.

Married individuals were the majority of the respondents (78.1%) compared to unmarried respondents. Notably, primary schooling accounted for the majority of respondents' educational attainment (59.4%). This suggests that there may be gaps in higher educational attainment that might further restrict access to technical expertise in conservation techniques in Bahi District.

About 82.6% of respondents were farmers which highlights the dependence on agriculture as a major occupation. Given that environmental conservation directly affects agricultural output, farming communities may have a stake in its success. Half of the respondents (50.0%) had families' sizes ranging from 1 to 5 family members, and the average family size was 4.73±0.15, which may serve as important labour required for agricultural work and conservation activities. Literature indicates that an increase of 1% of labor share from household increase farm productivity by 0.029% in Bahi District.

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Table 1: The distribution of the respondents according to their socioeconomic characteristics

Socio-economic characteristics	Wards				Overall (N=224)
	Bahi (N=56)	Ibihwa (N=56)	Mpamantwa (N=56)	Zanka (N=56)	
Gender					
Female	30 (53.6%)	31 (55.4%)	32 (57.1%)	25 (44.6%)	118 (52.7%
Male	26 (46.4%)	25 (44.6%)	24 (42.9%)	31 (55.4%)	106 (47.3%
Age					
20-40	32 (57.1%)	33 (58.9%)	31 (55.4%)	35 (62.5%)	131 (58.5%
41-60 Years	21 (37.5%)	16 (28.6%)	13 (23.2%)	14 (25.0%)	64 (28.6%)
60 Years and above	3 (5.4%)	5 (8.9%)	8 (14.3%)	5 (8.9%)	21 (9.4%)
Below 20 years	0 (0.0%)	2 (3.6%)	4 (7.1%)	2 (3.6%)	8 (3.6%)
Marital Status					
Married	50 (89.3%)	42 (75.0%)	42 (75.0%)	41 (73.2%)	175 (78.1%
Divorced	0 (0.0%)	2 (3.6%)	1 (1.8%)	1 (1.8%)	4 (1.8%)
Separated	1 (1.8%)	7 (12.5%)	3 (5.4%)	3 (5.4%)	14 (6.3%)
Single	5 (8.9%)	5 (8.9%)	10 (17.9%)	11 (19.6%)	31 (13.8%)
Education Level					
Certificate / Diploma	3 (5.4%)	0 (0.0%)	0 (0.0%)	1 (1.8%)	4 (1.8%)
No formal education	17 (30.4%)	16 (28.6%)	13 (23.2%)	6 (10.7%)	52 (23.2%)
Primary	30 (53.6%)	35 (62.5%)	35 (62.5%)	33 (58.9%)	133 (59.4%
Secondary	6 (10.7%)	5 (8.9%)	8 (14.3%)	16 (28.6%)	35 (15.6%)
Occupation					
Employed	1 (1.8%)	0 (0.0%)	0 (0.0%)	2 (3.6%)	3 (1.3%)
Entrepreneur such as traders	4 (7.1%)	6 (10.7%)	12 (21.4%)	10 (17.9%)	32 (14.3%)
Farmer	50 (89.3%)	50 (89.3%)	43 (76.8%)	42 (75.0%)	185 (82.6%
Other	1 (1.8%)	0 (0.0%)	1 (1.8%)	2 (3.6%)	4 (1.8%)
Family Size Group					
1-5	25 (44.6%)	27 (48.2%)	33 (58.9%)	27 (48.2%)	112 (50.0%
6-10	30 (53.6%)	28 (50.0%)	22 (39.3%)	28 (50.0%)	108 (48.2%
10-15	1 (1.8%)	1 (1.8%)	1 (1.8%)	1 (1.8%)	4 (1.8%)
Experience in Conservation					
1-10 Years	53 (94.6%)	53 (94.6%)	51 (91.1%)	52 (92.9%)	209 (93.3%
11-20 Years	3 (5.4%)	1 (1.8%)	3 (5.4%)	3 (5.4%)	10 (4.5%)
21-30 Years	0 (0.0%)	1 (1.8%)	2 (3.6%)	1 (1.8%)	4 (1.8%)
Above 30 Years	0 (0.0%)	1 (1.8%)	0 (0.0%)	0 (0.0%)	1 (0.4%)

The duration of respondents' participation in conservation efforts varied, with the majority (93.3%) having engaged in these activities for 1–10 years. The average involvement was 4.99±0.396 years, indicating that farmers have a moderate level of experience, which could positively influence their commitment to sustainable practices. Only 4.5% of participants had been involved for 11–20 years, suggesting that environmental conservation has a longstanding presence in the area. However, there may be room for improvement in engaging younger people. Additionally**,** the very low percentage of participants with over 30 years of involvement for more than 30 years (0.4%) implies that structured

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conservation programs may have only been introduced or that younger generations are increasingly taking on leadership roles in conservation. The socioeconomic characteristics, to the community's agricultural livelihoods, highlight their emphasis on environmental sustainability.

3.2 Adoption of different environmental conservation measures

3.2.1 Soil conservation

Results in table 2 show the soil conservation practices adopted by farmers in Bahi District. Cover cropping was the most commonly used technique for soil conservation, being used by 63.4% of respondents. The findings imply that farmers in the Bahi district readily access cover crops, and understand the need to preserve the soil health to guarantee the land's long-term production. Further, this high adoption rate might be explained by a number of variables. Smallholder farmers may afford the low-cost method of cover crops, which also offers further benefits including better soil fertility and animal feed. Moreover, the high adoption may further be driven by agricultural extension services and local organizations promoting sustainable farming practices. These findings are consistent with the study by Haruna et al., (2020) who emphasized that cover cropping has important ramifications for retaining moisture, improving soil fertility, and preventing soil erosion. In storing carbon in the soil, cover crops may also help slow down climate change, which may be an additional advantage for farmers.

It's interesting to note that 44.6% of respondents reported the use of organic farming methods. This means that organic farming is the second technique used by farmers in the Bahi district probably as a result of increased knowledge of the long-term advantages of organic matter in enhancing soil fertility and structure. The findings from this study indicate that the interest in sustainable farming methods among smallholder farmers is expanding. This is in line with Tal, (2018) who reported that the use of organic farming method is consistent with worldwide movements toward more environmentally friendly agricultural practices that support biodiversity and lessen the need for chemical inputs (Tal, 2018). The study by Baweja et al., (2020) emphasized that organic farming helps to improve soil fertility by eliminating synthetic fertilizers and pesticides, which over time may deteriorate soil health. However, the adoption rate, while notable, is not universal, suggesting possible barriers such as limited access to organic inputs, knowledge gaps regarding organic certification, or financial constraints in transitioning from conventional to organic practices.

About 41.1% of respondents surveyed mentioned agroforestry as another crucial technique for soil conservation. This means that agroforestry systems are the third most useful method for soil conservation in Bahi district. It's possible that Bahi's agroforestry adoption rate is modest because maintaining trees requires a long-term commitment and an initial financial outlay. But for those who have implemented it, the technique probably offers advantages for the

environment and the economy, such as shade for cattle and extra cash from tree products. This is supported by Kaushal et al., (2021) who revealed that agroforestry which incorporates shrubs and trees into livestock and agriculture systems, providing several advantages such as financial gain, sheds better soil structure, increased water retention, and biodiversity preservation. Other methods such as soil testing and monitoring, crop rotation, terracing, contour farming, grass strips, and mulching were not widely practiced by farmers in the study area.

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Table 2: Distribution of the respondents based on the soil conservation practices employed in their farming operations

Soil conservation	Wards				Overall (N=224)
	Bahi (N=56)	Ibihwa (N=56)	Mpamantwa (N=56)	Zanka (N=56)	
Cover cropping	34 (60.7%)	30 (53.6%)	40 (71.4%)	38 (67.9%)	142 (63.4
Agroforestry	11 (19.6%)	25 (44.6%)	26 (46.4%)	30 (53.6%)	92 (41.1
Organic farming	18 (32.1%)	31 (55.4%)	25 (44.6%)	26 (46.4%)	100 (44.6
Soil testing and monitoring	1 (1.8%)	8 (14.3%)	7 (12.5%)	11 (19.6%)	27 (12.1
Crop rotation	1 (1.8%)	3 (5.4%)	1 (1.8%)	0 (0.0%)	5 (2.2%)
Terracing	11 (19.6%)	8 (14.3%)	16 (28.6%)	14 (25.0%)	49 (21.9
Contour farming	7 (12.5%)	5 (8.9%)	11 (19.6%)	9 (16.1%)	32 (14.3
Grass strips	1 (1.8%)	5 (8.9%)	6 (10.7%)	10 (17.9%)	22 (9.8%
Mulching	15 (26.8%)	13 (23.2%)	17 (30.4%)	21 (37.5%)	66 (29.5
None	19 (33.9%)	20 (35.7%)	17 (30.4%)	11 (19.6%)	67 (29.9

It is noteworthy that although soil conservation methods are widely practiced among smallholder farmers in Bahi District, 29.9% of respondents reported not adopting any soil conservation measures. This finding suggests that despite the general prevalence of such techniques, a considerable proportion of farmers remain disengaged from their use. The lack of adoption may be attributed to factors such as limited awareness, financial constraints, or perceptions that these practices are ineffective in addressing specific agricultural challenges. Previous studies further highlight that cultural beliefs surrounding traditional farming systems, inadequate financial resources, and restricted access to agricultural extension services may also contribute to low adoption rates.

3.2.2 Water conservation

In Table 3 the study revealed that 51.3% of respondents in Bahi District do not practice any water conservation interventions, raising significant concerns for agricultural sustainability. This low adoption may result from financial constraints, limited knowledge, or inadequate access to resources and training, which have been identified in previous studies as key barriers to implementing water-saving strategies (Mekuriaw et al., 2018). Effective water conservation is essential in semi-arid areas like Bahi District, where rainfall is variable, to maintain agricultural productivity and ensure sustainable water management.

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Among the respondents, 33.0% reported practicing water recycling and reuse, making it the most widely adopted conservation method. This approach helps mitigate the effects of water shortages and reflects farmers' adaptation to uneven rainfall patterns. Reservoir construction was the second most common technique, adopted by 25.4% of respondents. Reservoirs store water during the rainy season for use in dry periods, providing a reliable supply and reducing dependence on rainfall (Yildiz & Özgüler, 2017). However, high labour and financial requirements limit wider adoption.

The findings indicate that improving access to resources, providing financial support, and enhancing education and training are essential to promote broader adoption of water conservation practices, thereby strengthening agricultural productivity and resilience in Bahi District.

Table 3: Distribution of the respondents based on water conservation practices

Conservation practices	Wards				Overall (N=224)
	Bahi (N=56)	Ibihwa (N=56)	Mpamantwa (N=56)	Zanka (N=56)	
Small scale water harvesting structures such as dams and ponds	2 (3.6%)	9 (16.1%)	13 (23.2%)	20 (35.7%)	44 (19.6
Reservoir construction	5 (8.9%)	12 (21.4%)	17 (30.4%)	23 (41.1%)	57 (25.4
Rain water harvesting	21 (37.5%)	15 (26.8%)	19 (33.9%)	19 (33.9%)	35 (15.6
Water cycling and reuse	3 (5.4%)	6 (10.7%)	12 (21.4%)	14 (25.0%)	74 (33.0
Wetland conservation	1 (1.8%)	6 (10.7%)	7 (12.5%)	3 (5.4%)	17 (7.6%
None of them	26 (46.4%)	37 (66.1%)	27 (48.2%)	25 (44.6%)	115 (51.3

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3.2.3 Storms/floods prevention

The findings presented in Table 4 show that 47.3% of respondents in Bahi District had never implemented any measures against storms or flooding, increasing their vulnerability to extreme weather. This inaction may result from limited knowledge, financial constraints, or the perception of low flood risk. However, failure to adopt flood control strategies can have long-term impacts on agricultural productivity and community resilience, particularly given the rising frequency of extreme weather events due to climate change.

Afforestation and reforestation were reported by 29% of respondents as a method for storm and flood prevention, making it the most commonly adopted technique. These practices improve water absorption, reduce surface runoff, and stabilize soil, lowering flood risks (Hanasaki, 2020). Levee construction was the second most adopted strategy at 28.1%, providing barriers against excessive rainfall and floods, though high construction and maintenance costs limit wider adoption. Contour farming, reported by 18.3% of respondents, was the third most used method, reducing soil erosion and runoff by plowing along land contours.

The relatively low adoption rates of these techniques highlight the need for education, practical demonstrations, and incentives to enhance awareness and encourage broader implementation of storm and flood prevention measures among smallholder farmers in Bahi District.

Table 4: Distribution of the respondents based on their practices of storms/flood preven

Conservation practices	Wards				Overall (N=224)
	Bahi (N=56)	Ibihwa (N=56)	Mpamantwa (N=56)	Zanka (N=56)	
Wetland conservation	1 (1.8%)	6 (10.7%)	7 (12.5%)	3 (5.4%)	17 (7.6%)
Afforestation and reforestation	4 (7.1%)	15 (26.8%)	20 (35.7%)	28 (50.0%)	67 (29.9%)
Contour farming	3 (5.4%)	7 (12.5%)	10 (17.9%)	21 (37.5%)	41 (18.3%)
Zoning of flood plains	5 (8.9%)	4 (7.1%)	6 (10.7%)	13 (23.2%)	28 (12.5%)
Levee constructions	20 (35.7%)	6 (10.7%)	16 (28.6%)	21 (37.5%)	63 (28.1%)
None of them	32 (57.1%)	36 (64.3%)	26 (46.4%)	23 (41.1%)	107 (47.3%)

3.2.4 Biodiversity conservation

The study found that 54.9% of respondents in Bahi District do not engage in any biodiversity conservation, highlighting low adoption among smallholder farmers. This may result from limited knowledge, scarce resources, or competing priorities such as food security and income. Biodiversity is essential for ecosystem resilience and agricultural productivity (Brooker et al., 2021), making

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increased participation critical for long-term sustainability. Community-based conservation was practiced by 29.0% of respondents, reflecting local engagement in managing natural resources. Such initiatives foster accountability and ownership, contributing to sustainable biodiversity management (Roka et al., 2020). However, the relatively low adoption rate indicates the need for additional support, resources, and awareness programs.

Other strategies, including forest and nature reserve protection (15.6%) and invasive species management (15.2%), were less commonly adopted. Forest reserves provide habitats and act as carbon sinks, while invasive species threaten native biodiversity and ecosystem stability. Limited involvement in these practices suggests farmers may be under-resourced or unaware of their importance. Targeted educational initiatives and technical support are necessary to improve understanding of the benefits of biodiversity conservation, promote sustainable practices, and enhance the resilience of ecosystems and agricultural systems in Bahi District.

Table 5: The distribution of the respondents based on the employed biodiversity conservation practices

Conservation practices	Wards				Overall (N=224)
	Bahi (N=56)	Ibihwa (N=56)	Mpamantwa (N=56)	Zanka (N=56)	
Habitat restoration	1 (1.8%)	3 (5.4%)	8 (14.3%)	15 (26.8%)	27 (12.1%)
Forest and nature reserves	2 (3.6%)	3 (5.4%)	14 (25.0%)	16 (28.6%)	35 (15.6%)
Management of invasive species	3 (5.4%)	6 (10.7%)	10 (17.9%)	15 (26.8%)	34 (15.2%)
Corridor creation	2 (3.6%)	4 (7.1%)	10 (17.9%)	16 (28.6%)	32 (14.3%)
Community-based conservation	22 (39.3%)	11 (19.6%)	17 (30.4%)	15 (26.8%)	65 (29.0%)
Others	1 (1.8%)	0 (0.0%)	1 (1.8%)	0 (0.0%)	2 (0.8%)
None of them	27 (48.2%)	45 (80.4%)	27 (48.2%)	24 (42.9%)	123 (54.9%)

3.2.5 Worm invasion and pest control interventions

In Bahi District, chemical pesticides are the most commonly used pest management practice, with 37.9% of farmers relying on them to control worms and pests. While effective, prolonged chemical use can harm ecosystems, reduce biodiversity, degrade soil, and pose health risks to farmers and consumers (Begum et al., 2017; Ojo, 2016). Notably, 33.5% of respondents reported not using any pest control methods, often due to limited resources, lack of awareness, financial constraints, or reliance on traditional approaches. This absence increases vulnerability to infestations, reduces crop yields, and threatens food security, while contributing to environmental degradation.

Integrated Pest Management (IPM) was adopted by 29.0% of respondents, combining biological, cultural, and chemical strategies to reduce environmental impact while controlling pests, Although IPM shows promise, its relatively low uptake highlights the need for training and education to

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promote sustainable pest management, reduce chemical dependency, and enhance agricultural productivity and environmental resilience in the district.

Table 6: The distribution of the respondents according to their practices of worm invasion and pest control

Conservation practices	Wards				Overall (N=224)
	Bahi (N=56)	Ibihwa (N=56)	Mpamantwa (N=56)	Zanka (N=56)	
Biological control	3 (5.4%)	5 (8.9%)	11 (19.6%)	15 (26.8%)	34 (15.2%)
Crop rotation	3 (5.4%)	9 (16.1%)	13 (23.2%)	19 (33.9%)	44 (19.6%)
Integrated pest management	16 (28.6%)	18 (32.1%)	21 (37.5%)	10 (17.9%)	65 (29.0%)
Greenhouse	0 (0.0%)	0 (0.0%)	4 (7.1%)	2 (3.6%)	6 (2.7%)
Chemicals	22 (39.3%)	19 (33.9%)	21 (37.5%)	23 (41.1%)	85 (37.9%)
None of them	18 (32.1%)	20 (35.7%)	16 (28.6%)	21 (37.5%)	75 (33.5%)

Crop rotation and biological control were other sustainable pest management technique adopted by 19.6%, and 15.2% of respondents respectively. The findings imply the lowest adoption of both crop rotation, and biological control. Despite crop rotation was reported by only a small portion of the respondents, the observation made indicates that some farmers are aware of its advantages, which include lowering the need for chemical inputs, increasing soil fertility, and controlling pests. The comparatively low use of this technique, nevertheless, might suggest that farmers lack the skills or resources necessary to carry out crop rotation successfully. Further, despite being ecologically beneficial, the low adoption rate of the biological control method shows that farmers may not be completely aware of its advantages or may not have access to biological control agents.

Literature pointed out that while crop rotation breaks the life cycles of pests by switching up the crops that the bugs need to survive (Nadeem et al, 2019), biological control methods entail using natural predators or parasites to manage pest populations (Hajek and Eilenberg, 2018). Reducing the need for chemical pesticides may be accomplished by promoting biological control via education and the distribution of biological control agents.

3.3 Drivers for farmers to participate in different environmental conservation practices

The multivariate probit analysis in Table 8 revealed different drivers for farmers to participate in different conservation practices. The Wald chi-square statistic $\chi2(90)$ =191.88, together with a p-value of 0.000, indicates that the Multivariate Probit Model adopt is highly significant. This demonstrates that different factors work together to affect farmers' involvement in different environmental conservation. This is consistent with the findings by Ochola, (2017) who pointed out that participation in different conservation practices depend on multiple factors.

The findings from this study indicate that training programs (TP) had a positive non statistically significant relationships with all the conservation practices. The positive relationship implies that promoting conservation practices among farmers is greatly aided by the availability of training

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programmes. Training initiatives encourage farmers to embrace sustainable methods by providing them with the technical know-how and abilities needed for efficient conservation. According to earlier studies, training is a major factor in determining environmental stewardship since it promotes knowledge and use of conservation strategies (Krara et al, 2025). However, the not significant relationship indicates possible inefficiencies of the training program in the study area.

Awareness raising campaign (AC) was found to have varying impacts on conservation methods. The findings in Table 8 show that AC had negative relationship with soil conservation, flood control, biodiversity conservation, and food/nutrition conservation, while they have a positive relationship with water conservation and pest/worm control. The negative and statistically non-significant relationship imply that raising awareness via awareness campaigns may not be enough to encourage active involvement in conservation initiatives. To turn knowledge into action, farmers may need more support. The results suggest that in order to increase the efficiency of information distribution in promoting conservation, it should be combined with practical training and material support.

The biodiversity conservation was found to be positively and significantly correlated with environmental awareness (EA), highlighting the role that ecological awareness plays in promoting conservation initiatives. This means that farmers are more likely to implement appropriate practices if they recognize the long-term benefits of biodiversity conservation. Although there were positive correlations, EA had no significant influence on other conservation practices, such as soil and water conservation. This implies that while knowledge is important; in order to have noticeable effects, it could need reinforcement via legislative actions, financial incentives, or peer pressure.

Table 8: Drivers for farmers to participate in different environmental conservation practices

Drivers	Dependent Vars (β)					
	SC	WC	FC	BC	PWC	FNC
TP	0.761	0.287	0.725	0.632	0.393	0.388
AC	-0.413	0.432	-0.339	-0.287	0.263	-0.079
EA	0.541	0.474	0.267	0.697 **	0.047	0.268
FS	-0.363	0.122	0.549 **	0.273	0.840 ***	0.870 ***
EI	0.804 *	-0.338	0.159	-0.098	0.108	0.091
CP	0.440	0.637 **	0.509 **	0.366	0.181	0.230
GR	-0.139	-0.067	-0.097	0.251	-0.034	0.433
BPES	0.071	0.090	0.181	0.362	0.391 *	0.158
CPPI	0.184	0.642 ***	-0.143	0.181	0.005	-0.093
Gender	-0.232	-0.481 **	0.085	-0.304	-0.085	-0.139
Marital Status	-0.217	-0.386	-0.499 *	0.000	-0.001	0.137
Education Level	0.707 ***	0.669 ***	0.378 **	0.525 ***	0.294	-0.060
Occupation	-0.262	-0.265	-0.323	-0.201	-0.442 **	-0.001
Age	0.231	0.050	0.228 *	0.259 *	0.230	-0.053
Family Size	-0.605 **	0.047	-0.047	-0.498 ***	-0.376 *	-0.273
_cons	-0.418	-3.962 ***	-1.121	-3.826 ***	-1.856 *	-0.216

*Note: Stars indicate statistical significance whereas * = p < 0.1, ** = p < 0.05, and *** = p < 0.01. Also, SC = Soil Conservation, WC = Water Conservation, FC = Flood Control, BC = Biodiversity Conservation, PWC = Pests/Worms Control, and FNC = Food/Nutritional Conservation, AC= Awareness Campaign, EA = Environmental Awareness, FS = Food Security, EI = Economic Incentives, CP = Community Peers, GR = Government Regulations, BPES = Belief that Participation in Environmental-conservation lead to Success of conservation, CPPI = Belief that Conservation Practices make Positive Impact in agriculture operations*

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The findings in Table 8 above indicate that improving food security (IFS) had positive and significant relationship driver flood control, worm/pest control, and food/nutritional conservation practices. These positive relationships are consistent Carrasco-Azzini et al., (2022) showing that smallholder farmers give food security top priority when making choices about their operations. Farmers are more inclined to adopt conservation methods that directly improve food security, highlighting the need of coordinating conservation methods with objectives for agricultural productivity.

Influence from community peers (CP) had a positive and statistically significant influence on flood control and water conservation. This highlights the significance of social networks in influencing environmental conservation behavior. According to social learning theories, farmers are more likely to embrace new farming methods if they see their peers using them effectively. This emphasizes how crucial community-driven conservation efforts and farmer-to-farmer information sharing are. To increase the rates of conservation adoption, extension programs should take advantage of social dynamics by implementing farmer cooperatives, demonstration farms, and peer-led training sessions.

The findings further reveal that government rules and regulations (GR) exhibited a mixed, non-significant relationship both positive and negative with conservation practices. This outcome implies that factors beyond GR may exert a greater influence on shaping conservation behavior. It also suggests that the existing policy framework may not be sufficiently effective in fostering consistent conservation efforts. Consistent with this observation, Messick et al. (2021) argue that promoting conservation behavior is often more effective through voluntary mechanisms such as incentive-based approaches, environmental education, and community participation rather than through stringent regulatory enforcement.

According to the findings, economic incentives (EI) had positive significant relationship with soil conservation; however it didn’t significantly influence other conservation practices. According to this research, farmers may depend on other factors like awareness, education, or social pressure when using various conservation techniques, even while financial incentives support soil conservation initiatives. Research shows that social and environmental factors also have a significant influence on conservation choices, therefore economic gains alone are not usually the deciding factor (Lu et al., 2022). As a result, conservation initiatives have to take a multifaceted strategy that incorporates monetary rewards with other forms of assistance.

The adoption of soil and water conservation methods was found to be positively and significantly correlated with higher education levels, indicating that farmers with greater educational attainment are generally more knowledgeable and technically capable of implementing sustainable practices (Occelli et al., 2021). Conversely, larger household sizes exhibited a negative and significant effect on soil conservation, biodiversity conservation, and pest or worm control, likely due to increased resource constraints. Gender was found to have a significant negative relationship with water conservation but showed no significant influence on other conservation practices. Furthermore, occupation had a negative and significant association with pest or worm control practices, whereas age demonstrated a positive and significant influence on flood control and biodiversity conservation. These findings suggest that household demographic characteristics play a crucial role in shaping conservation behavior, and thus, conservation interventions should be tailored to accommodate

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variations across different demographic groups.

In addition, the interrelationships among various conservation methods are presented in Table 9. The results revealed significant interdependencies between different conservation practices, as indicated by the correlation coefficients (rho).

The findings confirmed that conservation practices were linked rather than isolated (χ^2 (15) = 181.411, $p < 0.000$) for the hypothesis that all rho values are zero. This suggests that once farmers adopt one conservation technique, they are more likely to adopt complementary methods. The strong association observed between biodiversity conservation and soil conservation indicates that these practices are closely linked and often adopted simultaneously. As noted by Leal-Filho et al. (2023), preserving biodiversity enhances soil health, and improved soil quality, in turn, supports biodiversity. Moreover, the strong positive correlations between flood control and soil conservation, as well as between water conservation and soil conservation, further demonstrate that land and water management practices tend to be applied synergistically.

Table 1: Interdependencies of different environmental conservation practices

rho	Definition of rho notation	β	Sig
rho21	WC and SC	0.388	***
rho31	FC and SC	0.646	***
rho41	BC and SC	0.807	***
rho51	PWC and SC	0.328	*
rho61	FNC and SC	0.546	***
rho32	FC and WC	0.660	***
rho42	BC and WC	0.670	***
rho52	PWC and WC	0.519	***
rho62	FNC and WC	0.270	**
rho43	BC and FC	0.800	***
rho53	PWC and FC	0.560	***
rho63	FNC and FC	0.596	***
rho54	PWC and BC	0.504	***
rho64	FNC and BC	0.581	***
rho65	FNC and PWC	0.580	***

Note: Stars indicate statistical significance whereas * = $p < 0.1$, ** = $p < 0.05$, and *** = $p < 0.01$.

Effective water management promotes ecological stability, biodiversity, and pest control, while soil conservation, flood management, and biodiversity protection collectively enhance food and nutrition security. These interlinkages underscore how sustainable conservation practices contribute to agricultural resilience and long-term food security. They further emphasize the need for integrated conservation strategies that simultaneously advance environmental sustainability and human well-being. This finding aligns with previous studies demonstrating that sustainable conservation interventions play a pivotal role in strengthening agricultural resilience and ensuring food security (Joshi et al., 2021).

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5.0 CONCLUSION

The study concludes that farmers' participation in environmental conservation is influenced by a combination of social, educational, and demographic factors rather than by financial incentives alone. Although the data indicate that larger household sizes tend to constrain participation, social influence, environmental knowledge, and concerns about food security play a more substantial role in shaping the adoption of conservation practices. These results highlight that underlying structural and social dynamics consistently affect conservation behavior, underscoring the interdependence between human systems and sustainable environmental management.

Promoting conservation practices requires an integrated approach that combines education, community participation, policy support, and continuous monitoring. Educational initiatives should highlight the role of conservation in strengthening food security, economic growth, and environmental sustainability through farmer field schools, demonstration sites, and digital learning platforms. Community-driven mechanisms such as peer influence, recognition programs, and the dissemination of local success stories can further encourage adoption, while the establishment of local committees helps to embed these practices within social structures.

Water and biodiversity conservation efforts should prioritize rainwater harvesting, reservoir development, invasive species control, and ecosystem restoration to enhance resource sustainability and ecological resilience. Robust policy frameworks and inclusive decision-making processes are essential, supported by targeted incentives such as grants and subsidies to motivate participation. Furthermore, promoting integrated pest management reduces dependence on chemical inputs, while ongoing research and systematic monitoring ensure continuous, evidence-based improvement in conservation outcomes.

Ethical Clearance

This research has received ethical clearance from relevant ethics committee at Sokoine University of Agriculture. All necessary permissions and consents have been obtained from involved stakeholders and participants.

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Conflict of Interest

I hereby declare that I have no financial or personal conflicts of interest that could have influenced the research process or outcomes.

Authors' Contributions

This manuscript is solely authored by me G.I.M Conceptualization: G.I.M Writing-original draft: G.I.M Methodology: G.I.M Formal analysis and Interpretation: G.I.M, Writing-Review and editing: G.I.M, J.S.M, H.M, Supervision: J.S.M, H.M.

Availability of Data and Materials

All data and materials associated with this research will be made available upon request. The data will be shared according to the procedures and policies of Sokoine University and in accordance with ethical guidelines.

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